Claims

[c1] 1. An analytical device comprising:
a substrate having a first surface;
a crater formed in the first surface of said substrate;
a sensing element integrated within said substrate proximal said crater, said sensing element configured to detect one or more physical properties within said crater; and
a force transduction element located proximal the crater and configured to generate a field that attracts one or more sample particles toward the crater, wherein at least one of said one or more particles is of sufficient size to close the opening in the first surface of the substrate defined by the crater.

[c2] 2. The device of claim 1, wherein the sensing element is located proximal the bottom of the crater.

[c3] 3. The device of claim 1, wherein the sensing element is located proximal a side wall of the crater.

[c4] 4. The device of claim 1, wherein the sensing element is selected from the group consisting of a pH sensor, an optical sensor, a radiation sensor, a magnetic induction sensor, a temperature sensor and a pressure sensor.

[c5] 5. The device of claim 1, wherein the force transduction element includes one or more conducting coils, said conducting coils producing a magnetic field when a current is applied thereto.

[c6] 6. The device of claim 5, wherein said one or more coils are located around the perimeter of the crater opening proximal the first surface of the substrate.

[c7] 7. The device of claim 5, wherein said one or more coils are located around the perimeter of the crater extending into the substrate along at least a portion of the crater depth.

[c8] 8. The device of claim 5, wherein said one or more sample particles each include a magnetic or magnetizable bead.

[c9] 9. The device of claim 1, wherein the opening in the substrate define by the crater is one of a circular and a square opening.

[c10] 10. The device of claim 1, wherein the depth of the crater is less than about 1 mm deep.

[c11] 11. The device of claim 1, wherein the width of the crater opening is less than about 1 mm.

[c12] 12. The device of claim 1, wherein the force transduction element includes one or more conducting electrodes, said electrodes producing an electrostatic field when a voltage is applied thereto.

[c13] 13. The device of claim 12, wherein said one or more sample particles each include an electrically charged bead.

[c14] 14. The device of claim 1, wherein one or more of said sample particles are directed into the crater by the field generated by the force transduction element.

[c15] 15. An analytical device comprising:
a substrate having a first surface;
a crater formed in the first surface of said substrate;
a lid particle introduced in a fluid medium proximal said crater, wherein said lid particle is of sufficient size to close the opening in the first surface of the substrate defined by the crater; and
a force transduction element located proximal the crater and configured to generate a field that attracts said lid particle toward the crater in response to a control signal so as to close the crater.

[c16] 16. The device of claim 15, wherein the force transduction element includes one or more conducting coils.

[c17] 17. The device of claim 16, wherein said one or more coils are located around the perimeter of the crater opening proximal the first surface of the substrate.

[c18] 18. The device of claim 16, wherein said one or more coils are located around

the perimeter of the crater opening extending into the substrate along at least a portion of the crater depth.

[c19] 19. The device of claim 16, wherein the lid particle includes a magnetized micro-bead.

[c20] 20. The device of claim 15, wherein the force transduction element includes one or more conducting electrodes.

[c21] 21. The device of claim 20, wherein the one or more electrodes are positioned proximal the perimeter of the crater opening.

[c22] 22. The device of claim 20, wherein the one or more electrodes are positioned within the crater.

[c23] 23. The device of claim 20, wherein the lid particle includes an electrically charged micro-bead.

[c24] 24. The device of claim 15, further comprising a sensing element integrated within said substrate proximal said crater, said sensing element configured to detect one or more physical properties within said crater.

[c25] 25. The device of claim 24, wherein the sensing element is located proximal the bottom of the crater.

[c26] 26. The device of claim 24, wherein the sensing element is located proximal a side wall of the crater.

[c27] 27. The device of claim 15, further comprising a sensor module including a sensing element, wherein said sensing module is positioned proximal said substrate such that said sensing element is located proximal the bottom of said crater.

[c28] 28. The device of claim 15, further comprising a sensor module including a sensing element, wherein said sensing module is positioned proximal said substrate such that said sensing element is located proximal a side wall of said crater.

[c29] 29. The device of claim 15, further comprising one or more sample particles introduced in said fluid medium, wherein at least one of said sample particles is directed into the crater by the field generated by the force transduction element prior to the crater being closed by the lid particle.

[c30] 30. An analytical device comprising:
a substrate having a first surface;
a crater formed in the first surface of said substrate;
a sensing element integrated within said substrate proximal said crater, said sensing element configured to detect one or more physical properties within said crater; and
a sample particle introduced in a fluid medium proximal said crater, wherein said crater is substantially commensurate in shape and size with a portion of said sample particle so as to hold said sample particle in place therein.

[c31] 31. An analytical system, comprising:
a substrate having a first surface;
a crater formed in the first surface of the substrate, said crater defining an opening in the first surface of said substrate; and
means for closing said opening so as to substantially seal off samples trapped in the crater from the surrounding environment.

[c32] 32. The system of claim 31, wherein said means for closing includes a micro-bead of sufficient size to close the opening and a force transduction element configured to direct the micro-bead to the opening.

[c33] 33. The system of claim 32, wherein the micro bead is a magnetized bead, and wherein the force transduction element includes one or more conducting coils.

[c34] 34. The system of claim 32, wherein the micro bead is an electrically charged magnetized bead, and wherein the force transduction element includes one or more conducting plates.

[c35] 35. The system of claim 31, wherein the means for closing the opening includes a micro-shutter.

[c36] 36. The system of claim 31, wherein the means for closing the opening includes one of an electrostatically controlled sliding door and a magnetostatically controlled sliding door.

[c37] 37. The system of claim 31, further comprising sensing means located proximal the crater for sensing one or more conditions within said crater..

[c38] 38. The system of claim 37, wherein the sensing means includes one of a pH sensor, an optical sensor, a radiation sensor, a magnetic induction sensor, a temperature sensor and a pressure sensor integrated in the substrate.

[c39] 39. A method of localizing known amounts of sample materials at each of one or more specific locations on a substrate, each specific location including an individually addressable force transducing element, the method comprising;
providing a plurality of sample particles proximal the substrate;
selectively activating one or more of said force transducing elements, wherein each activated force transducing element generates a field that attracts said particles to the corresponding specific location; and
detecting, at each activated location, the number of particles attracted to the location.

[c40] 40. The method of claim 39, wherein each location includes a crater formed in said substrate proximal the force transducing element.

[c41] 41.The method of claim 40, wherein the sample particles include magnetized beads, and wherein detecting includes detecting inductance changes in one or more conducting coils proximal the crater, said inductance changes caused by said particles entering said crater.

[c42] 42.An analytical device comprising:
a substrate having a first surface; and
an array of locations patterned on the substrate, each location including:
a crater formed in the first surface of said substrate;
a sensing element integrated within said substrate proximal said crater, said sensing element configured to detect one or more physical properties within said crater; and

a force transduction element located proximal the crater and configured to generate a field that attracts one or more sample particles toward the crater; and

a fluid medium disposed proximal at least a portion of said array of locations, said fluid medium including a plurality of said sample particles.

[c43] 43. The device of claim 42, wherein said plurality of sample particles includes a plurality of lid particles, each of sufficient size to close one of the openings in the first surface of the substrate defined by said craters.

[c44] 44. The device of claim 42, wherein said plurality of sample particles are each substantially commensurate in shape and dimension as the craters.

[c45] 45. The device of claim 42, wherein said sample particles include magnetic or magnetizable micro-beads.